

Processing and Preservation of Horticultural Crops

Processing: In Agriculture, Processing may be defined as convert an agricultural commodity into marketable form by a special series of steps such as pasteurization, drying, heating, cooling etc.

Preservation: In Agriculture, Preservation is a process to keep safe the commodities from injury, harm or destruction by applying some action like pickling, canning, fermentation etc.

Importance of fruit and vegetable preservation and processing

1. Preservation process can reduce the losses of horticultural commodities.
2. Processed fruits and vegetables can solve our nutritional problem by providing nutrients even in off season.
3. It makes fruits and vegetables products available year around.
4. Processing enhances modernization of agricultural production system and we help us for receiving higher price of crops.
5. Earning foreign exchange by ensuring quality of processed product to meet International standards. e.g. PRAN industries.
6. It can ensure employment opportunities to rural people by providing training.

Principles of processing and Preservation of fruits and vegetables

The general principle of preservation of fruits and vegetables are two types-

A. Principles for temporary preservation.

B. Principles for permanent preservation.

A. Temporary preservation

1) Asepsis: To reduce the growth of microorganisms. The principle of asepsis is carried to a much higher degree of the product. The inception of spoiling of a food product depends largely upon the number of microorganisms present. In the handling of fruits for the manufacturers of various fruit products care in picking placing in boxes and transportation will greatly increase the keeping quantities of the fruits and will usually result in a finished product of superior quality.

Washing dirty fruits and vegetables before they are used in the manufacture of certain products is often advisable and reduces the number of microorganisms. The principles of asepsis is carried to a much higher degree in the manufacture of serum, vaccine and antitoxins.

2) Low Temperature: To reduce the multiplication of organisms and to retard chemical changes of the product. Microorganism are not killed by low temperatures but their multiplication and activities are inhibited. Low temperatures also retard chemical changes.

3) Exclusion of moisture: The product should be stored in a dry atmosphere. Moisture is necessary for the development of microorganisms and the actual growth of mould and other organisms on or in food production takes place in the juice product. Chemical changes in flour, cereals, dehydrated vegetables oils etc are favoured by the presence of moisture; hence products should be stored in a dry atmosphere.

4) Mild aseptic: Preservatives such as sugar, salt, sodium benzoate, Sulphur dioxide etc. when in small quantities exert only a temporary effect upon the microorganisms of spoilage. Vinegar and spices in catsup will prevent spoilage for a time usually for several weeks after the bottle is opened.

5) Pasteurization: It is a temperature treatment which applied to the preservation of liquids as fruit juice. When a product is subjected to a temperature that kills a great many but not of the organisms present the process is spoken *pasteurization*. The term "pasteurization" is often to the preservation of fruit juice by heat.

6) Exclusion of Air: The exclusion of air will prolonged are keeping qualities of processed products. Most fermented products such as wine, fermented vegetables and Green Olive pickles must be sealed in airtight containers to prevent the growth of aerobic organisms which would spoil them.

B. Permanent preservation

1) Permanent preservation of spoiling: The method will depend upon the character of the materials to be preserved and upon some factors.

2) Sterilization or processing by heat: Fruit juices are usually processed commercially through sterilization at temperature ranging from 65-85°C. Higher temperature injures flavour. Vegetables except those of high acidity, when sterilized by one heating must be heated at 100°C for 1-3 hours to be certain that all spores are killed.

3) Permanent preservation by antiseptics: Some antiseptics such as sugar, salt and vinegar are harmless and may be used without reference to the pure food laws. Sugar used in concentration of 70% or over will permanently preserve most foods like fruit, jellies etc. It acts by osmosis and not as a true microorganisms poison, hence it is much for effective than sugar about 15% salt is sufficient to preserve most products.

4) Drying: The amount of drying will depend largely upon the composition of the food. Thus, fruit very rich in sugar are not usually dried to as low a moisture content as fruits low in sugar.

5) Fermentation: Fermentation is a process of decomposition of Carbohydrates by microorganisms or enzymes which may be defined as the bacterial decomposition of proteins. 3 types of fermentation can be used in processing-

- Alcoholic fermentation. e.g. alcoholic beverages.
- Acetic fermentation. e.g. pickles, ketchup etc.
- Lactic fermentation. e.g. Dill pickles, fermented beans, green olives etc.

Processing and preserving methods of Fruit and Vegetables

To process and preserve fresh produce successfully, the spoilage agents must be destroyed without ruining the nutritional value or palatability of the produce itself. Unfortunately fruit, vegetables and root crops are the only natural source of the essential vitamin C in our food. This vitamin is easily destroyed, especially where processing makes use of heat. In order to retain the maximum amount of vitamin C in processed food, it:

- Should be used when freshly harvested;
- Must not be subjected to long soaking or washing;
- Must be processed immediately after preparation;
- Should not be treated in copper, iron or chipped pans.

The best methods for small-scale processing are: drying, chemical preservation and heat processing.

A. Drying

All living materials require water for survival. Fresh produce contains up to 95% water and thus is sufficiently moist to support both enzyme activity and growth of micro-organisms. The aim in drying is to reduce the water content of the produce to a level insufficient for enzyme activity or the growth of micro-organisms. The critical level is about 10-15% moisture, depending on the commodity. If too much water is removed, the product becomes brittle and is easily shattered.

Produce can be dried by using solar or artificial heat. Solar (sun) drying is cheap but is not so easily controlled as dehydration by more sophisticated means. In some countries, heat from burning agricultural waste is used for drying, as in copra driers, which have also been used for drying root crops.

Drying by direct exposure to the sun has a number of disadvantages:

- Exposure of produce to dust and atmospheric contamination
- Interference from animals and humans

- Insect infestation
- No control of conditions.

Recently much research has gone into the design of solar driers for fresh produce in order to overcome these problems. Solar driers can be:

- *Direct exposure driers*, in which the prepared produce is exposed to the sun in a ventilated cabinet with transparent sides and cover, on an insulated, heat-absorbing base; there is little control of temperature or air flow.
- *Indirect exposure driers*, in which an inclined, insulated heat trap directs a flow of sun-heated air up a tower where produce is exposed on mesh trays; the air flow and temperature can be controlled by louvres at the air inlet and outlet.
- *A combination of direct and indirect drying* is employed when the walls of the tower of an indirect drier are covered with transparent material so that there is some direct exposure of the drying material to the sun's heat.

The rate of loss of vitamin C from the produce is reduced when the indirect solar drying method is used. Drying should be as rapid as possible in order to maintain quality and minimize vitamin loss. The rate of drying depends on:

- The exposure of a large surface area of the produce, which speeds drying; most produce should be cut into strips not more than 5 mm thick;
- The temperature should be high enough (50-70°C) to give rapid moisture removal; temperatures over 70°C cause discoloration of the product.
- The warm air current must be dry; if it is humid, it cannot absorb moisture from the drying product.

Special treatments may be given to certain types of produce before drying; for example:

- Fruit and vegetables may be treated with sulphur dioxide before drying in order to prevent enzymatic browning; it also slows breakdown of vitamin C and kills some micro-organisms.
- Most vegetables except onions and garlic are blanched by dipping them in hot water for a few minutes before drying; this stops the action of enzymes which may not be killed by the sun-drying process.
- Green vegetables retain their colour better during drying if about 0.25% of bicarbonate of soda is added to the blanching water, but this will speed up the loss of vitamin C.

- Dried cassava forms an important part of the staple diet in parts of Africa and Latin America; the dried product may be in the form of chips, granules or flour; in some areas the grated cassava root is fermented for a short time before being dried by artificial heat or sunlight.
- Dried vegetable products are subject to severe insect infestation, and some may be affected by exposure to light during storage; dried produce must be stored in a very dry atmosphere, in insect-proof containers and away from light.

B. Processing using chemicals

Chemicals used in processing include sugar, salt, vinegar and chemical preservatives such as sodium meta-bisulphite. The principal products are:

Preserves with sugar: This is based on using a high concentration of sugar with fruit pulp or juice to create a product in which it is difficult for moulds and yeasts to grow. It includes:

- **Jams and jellies:** In these products acidified fruit pulp is boiled with sugar until the cell wall pectins of the fruit form a gel. The final product should contain at least 60% sugar. The hot preserve is sealed in sterilized jars to prevent contamination during storage.
- **Fruit cheeses:** Pulped fruit is sieved and mixed with an equal weight of sugar. The mixture is heated to remove most of the water. It is then spread on trays to cool and dry; then it can be cut into cubes and stored under very dry conditions.
- **Fruit drink concentrates:** The juice is extracted from heated fruit pulp and made into a syrup with a high sugar concentration. The squash or syrup is put into sterilized bottles, which are heated in a bath at 88°C (simmering) for 20 minutes. The bottles are closed with sterile caps for storage. Drinks are prepared by diluting the concentrate with water.

Pickled vegetables: Young fresh vegetables of many types as well as some fruits can be preserved by pickling in vinegar. The prepared vegetables or fruit are first soaked for a few days in a strong salt solution (brine) and then packed into jars which are then filled with cold vinegar. The vinegar is usually flavoured by steeping the desired spices in it for one or two months. The jars should be closed with plastic-lined covers.

Preservation with salt: This method is usually used for preserving green beans. Young green beans and salt are placed in alternate layers in large glass or earthenware jars, the top layer being of salt. The jars are closed with moisture-proof covers and then they are stored on stands.

Fermented products: In several countries vegetables are subjected to lactic acid fermentation in brine, such as *sauerkraut* in Germany, made from shredded cabbage, and *takuwan* in Korea, using radishes. In the Pacific islands, a fermented product is made by burying peeled starchy produce in pits lined with Heliconia or banana leaves. The product, known as masi or ma, is mostly made from breadfruit, but green bananas, cassava roots or taro may also be used.

C. Heat treatments

For many years fruit and vegetables have been preserved by heat, using canning or bottling methods. The object is to kill the enzymes and micro-organisms by heating the produce in liquid in cans or jars. The containers are then sealed while still hot to prevent contamination of the sterilized contents. Although moist heat inactivates enzymes and kills most micro-organisms, some bacteria, such as *Clostridium* and *Staphylococcus* are heat-resistant and are capable of growing and producing poisons in canned or bottled foods. *Clostridium* produces a toxin which causes botulism, a fatal food poison.

Acid foods, such as fruit, inhibit the growth of *Clostridium* and prevent the formation of the poison.

Non-acid foods such as peas and beans and almost all vegetables can be preserved only by heat at the high temperatures achieved in steam-pressure vessels. For this reason, heat-processing methods are not recommended for processing any vegetables under small-scale local conditions.

D. Manufacturing process

Any industrial manufacturing process has 2 type of operation-

- I. Separation of valuable materials from less valuable materials.
- II. Conversion of raw materials into new products.

I. Separation of valuable materials from less valuable materials

- **Crushing and pression:** Crushing and pressing are used in the separation of the valuable juice and saps from the less valuable pulp and fibre.
- **Filtration:** Many liquid such as fruit juice, wines, vinegars vegetables, oils etc contain solid material that must be removed by filtration.
- **Floatation:** Materials that are mixed and of different specific gravities may be separated by placing them in liquid in which one will sink and the other well float.

- **Leaching:** Sugar, alcohol and other soluble materials may be separated from fruit pumice.
- **Diffusion:** This method is used mostly beet sugar manufacture. It depends upon osmosis. i.e. the tendency of liquids outside and inside, the cell to come to the same concentration.
- **Distillation:** Volatile compounds can be separated from less volatile ones by distillation.
- **Centrifugal separation:** Centrifugal force is used in the clarification of fruit juice. The separation of oil from water and fruit juice.
- **Crystallization**
- **Shifting:** Mechanical shifting is used to separate coarse from fine materials. It may be used in separating grape seed from the skin.
- **Size classification:** Certain fruits and vegetables are separated into several sizes.

II. Conversion of raw materials into new products

Many raw products must be transformed into new products by process some of which are chemical in nature and other mechanical.

- Fermentation.
- Alcoholic fermentation.
- Pure cultures.
- Other fermentations.
- Hydrolysis.

Primary operation for processing fruits and vegetables

1. **Washing fruits and vegetables:** Washing is an important operation that generally is the point of departure of any fruit and vegetable production process. Fruits and vegetables may be washed with water in their different ways: soaking, washing by agitation and sprays.
2. **Soaking:** Soaking is not itself an effective means of removing dirt but is useful as a preliminary treatment to washing by sprayers or by agitation. e.g. Tomatoes are usually dumped into a soaking wash tank.

3. **Washing by sprays:** Washing of Fruit and Vegetables by means of sprays of water is by far the most satisfactory method.
4. **Scalding and Blanching:** Most vegetables are heated in water or in live steam before Canning. This treatment being known among canners as blanching. It cleanses the product and decreases the volume.
5. **Peeling fruits and vegetables for canning:** The quality of certain canned fruits and vegetables depends in large measure upon the care taken in peeling.

► **Hand peeling:** During the first years of fruits Canning industry in California peaches are peeled by hand. At present time commercial canners do not peel the fruits in this manner but used instead the lye peeling system.

► **Lye peeling:** Lye peeling was probably first used commercially in the production of hominy. Hominy is made by boiling corn in dilute sodium hydroxide solution. Lye peeling is used on peaches, sweet potatoes, apricots and carrots.

Processing of mango jam

Both ripe and underripe fruit is used.

- The mangos are washed, peeled and cut into small slices with a stainless steel knife. The amount of sugar required represents 60% of the weight of the mangoes prepared.

The cooking is done in two stages

1st STEP, consists in adding 70% of the amount of sugar calculated, plus 2 spoons of lemon juice per Kg of mango. Stir well during the entire cooking until 50° Brix of solids by refractometer is reached.

2nd STEP, consists in adding the remaining 30% of the sugar plus 2 spoons of lemon juice per kg of mangos. Stir well during the entire cooking, until 67-68° Brix of solids by refractometer is reached.

The jars are filled while the mixture is hot ("hot-fill" process). During the operation the jam must be stirred with the handle of a wooden spoon in order to eliminate the air that has entered the jars. The jars are closed with screw-tops. Jars cooling, washing and labelling are the last stages before storage.